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TFW Road Questionnaire:

Analysis and Compilation of Responses

By

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TIMBER FISH
&WILDLIFE

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TFW ROAD QUESTIONNAIRE - JULY 1990
ANALYSIS AND COMPILATION OF RESPONSES

A. INTRODUCTION

A questionnaire on forest roads was developed by the Sediment, Hydrology and Mass Wasting Subcommittee (SHAMW) of the TFW Cooperative Monitoring, Evaluation, and Research Committee (CMER) as a first step in determining the effectiveness of forest road construction methods and regulations in Washington.

Roads associated with forest practices can have significant impacts on water quality and aquatic habitat, and contribute to mass wasting. A significant portion of Washington's forest practices rules and regulations involve various aspects of roads and landings, including design and maintenance of the surface and drainage structures, placement of fill and waste material from excavation activities, and reduction of organic debris from clearing operations.

This questionnaire was developed to provide road construction engineers, regulators, and other individuals involved with forest roads an opportunity to provide information to TFW cooperators on what's working and not working in the field; to identify information needs; to offer suggestions for further research; and to identify any needed changes in regulations governing forest roads. The results of this questionnaire will be used to create a catalog of workable techniques and to establish a network of successful operators.

The questionnaire was originally distributed in August, 1990 to personnel working within TFW as well as to forest road engineers at National Forests in Washington. The original response due date of September 30 was extended several times to encourage wider distribution among agencies and the timber industry and to obtain as many responses as possible. In late 1990, there was severe flooding in many areas of the state and damage to or failure of a number of forest roads. Additional questionnaires were distributed and the response deadline extended to January 15, 1991, to respond to an anticipated increase in interest in forest road design, maintenance and closure issues as a result of these events.

All questionnaires received as of February 11, 1991 are tabulated and analyzed in this report.

B. SUMMARY OF RESPONSES

GENERAL INFORMATION

A total of 46 questionnaires have been tabulated.

Responses are very evenly distributed among the TFW regions, with a slightly lower return from the Northwest Region. One anonymous response was received.

Respondents are relatively evenly divided among large industrial landowners, federal agencies, and state agencies. Small landowners and forestry consultants returned three questionnaires among them.

Most respondents work in a variety of road-related fields, with no one field dominating the responses.

Over 85% of the respondents have worked on/with forest roads for 10 or more years. Over 40% have more than 20 years experience.

Approximately 25% of the respondents' companies or agencies construct 1-5 miles of road in a typical year. Other companies and agencies are evenly split among those constructing 10-20, 20-30, 30-50 and more than 50 miles per year. Over half of the respondents maintain more than 30 miles of road in an active state. Almost 90% maintain more than 25 miles of road in an inactive state and over 50% maintain 100-500 miles in an inactive state.

Sixty percent of the respondents believe that TFW should sponsor a workshop on forest roads and 80% would attend. Winter is clearly the preferred time of year for such a workshop.

Sixty percent of the questionnaires have been completed by one individual. Almost 20% have been completed by teams of four or more persons.

BRIDGES AND MAJOR CULVERTS (fish-bearing streams)

No one factor dominates the design or sizing of culverts for fish-bearing streams. Headwater depth, sediment passage, fish passage and debris passage are of relatively equal importance in culvert design. Design flood, channel width, basin area and culverts downstream are relatively evenly utilized as culvert size factors. Design-flow recurrence intervals of either 50-year or 100-year are utilized by over 80% of the respondents.

The rational method is cited as the most effective means of determining design flows by close to half the respondents. USGS publications and other methods are both cited by over one-third of the respondents as being very or somewhat effective. Soil Conservation Service and DOT methods are not frequently utilized. Less than half of the respondents indicate that design flow methods are regionalized to their area.

Almost three-quarters of the respondents modify bridge or culvert flow capacity to accommodate organic debris passage during flood flows. Slightly more than half will modify for debris and sediment passage during debris flows. A variety of methods, including subjective approaches, are utilized in designing for debris passage. These methods are felt to be very or somewhat effective by 60% of the respondents.

Special techniques for protection of stream crossings from debris jamming are employed by over 85% of the respondents.

Armored wingwalls, armored fills, and overflow spillways are rated by at least half the respondents as very or somewhat effective in both protecting roads and protecting water quality and/or fish habitat from debris and flood flows. Removable grates are the least utilized of the techniques cited.

All respondents consider stream crossings in their initial road alignment planning. Bank stability, preferred road alignment, road alignment limitations and favorable approach angles are rated as the most effective criteria for locating major stream crossings to protect roads by over 80% of the respondents. Logging system layout, access and ownership and stream gradient are also very effective criteria for more than half the respondents. In terms of protecting water quality and/or fish habitat, all criteria except access and ownership are ranked as similarly effective.

The Forest Practices Board Manual and DOF guidelines are rated as very or somewhat effective in ensuring fish passage by about half the respondents. Approximately 40% also cite USFS guides or other guidelines as effective.

Temporary crossings are used instead of permanent structures in a wide variety of situations, but generally only for short seasonal use. Approximately 80% of the respondents feel that these temporary crossings are very or somewhat effective both in providing access and in protecting water quality and/or fish habitat.

MINOR STREAM CROSSINGS (headwaters, side streams)

One-third of the respondents install/review 50-100 minor-crossing culverts per year. About one-quarter each install/review either 10-50 or 100-500 culverts per year. Three respondents install/review in excess of 500.

Half the respondents repair or replace 2-5% of their minor-crossing culverts per year. Only one respondent repairs/replaces more than 10% per year. Debris jams are the most typical types of failures, followed in order by fill failures and hydraulic damming. No one typical cause of failure is identified, although catastrophic storms, under-design and debris jams from debris torrents are most frequently cited.

Over 60% of the respondents use the same design flow methods for minor and major stream crossings. The rational method is identified as being the most effective in determining design flows for minor streams. Few respondents utilize Soil

Conservation Service or DOT methods. About half the respondents indicated that these methods are regionalized to their area.

Slightly more than half the respondents modify culvert flow capacity to account for debris (organic and/or sediment) passage. These modifications are most typically based upon the site specific situation rather than on regulatory standards. About 60% of these respondents find the modifications to be effective in providing adequate flow capacity.

Two-thirds employ special techniques for protection of minor stream culverts from debris jamming. Armored fills, followed in order by trash racks, armored wingwalls and overflow spillways, are identified as being most effective in protecting roads from debris and flood flows. A similar rating is given to these techniques in protecting water quality and/or fish habitat. Removable grates are not generally employed by the respondents.

CROSS-DRAIN DESIGN

18-inch culverts appear to be the most widely utilized size of cross-drains, constituting more than half the cross-drains for more than 90% of the respondents. Eighty percent use culverts over 24-inches in size, water bars or drivable dips 10-25% of the time. One-third use 15-inch culverts 25-50% of the time. 24-inch culverts are used 10-50% of the time by about half the respondents. Slot-top culverts are the least utilized type of cross-drain.

The Forest Practices Board Manual, USFS guides and a variety of other techniques are all rated as very or somewhat effective in determining cross-drain spacing. DOF guidelines are not generally used. Road grade, presence of groundwater and highly erodible soils are the reasons most frequently cited for adjusting cross-drain spacing. Dips in topography (unchannelized), erosion hazard below the discharge point, and grade of road are each cited by about one-quarter of the respondents as criteria for determining cross-drain discharge points.

Flumes (1/2 round culverts) and full culverts with open elbows are identified as the most effective types of downspouts (spillways), followed by rock rip-rap, full culverts with closed elbows, and slash and/or other harvest by-products. Rigid plastic and plastic socks are not considered to be very effective.

Over 80% of the respondents rate seeding and seeding/mulching of cut and fill slopes as very or somewhat effective both in protecting the road prism from erosion and in protecting water quality and/or fish habitat. Approximately 70% also rate energy dissipators on culvert outfalls and a variety of other techniques as very or somewhat effective. When these methods do not work well it is typically because most of the erosion occurs before the methods can take effect or because they are effective for only a short period of time.

EROSION PROTECTION FOR FILL

Approximately four out of five respondents typically protect fills adjacent to streams from erosion. Rip-rap is rated as very or somewhat effective in protecting fill by more than 90% of the respondents. Gabions and a variety of other methods are considered to be very or somewhat effective by about 60% of the respondents. Erosion blankets are considered to be the least effective of the methods cited.

The Forest Practices Manual is identified as the most effective method in determining the 50-year flood level. Forest Service guides are cited as the least utilized method. Sixty percent of the respondents provide protection above the 50-year flood level.

MASS MOVEMENT

In "normal years", less than 5% of the road networks of 90% of the respondents suffer some kind of landsliding. In wet years, about 70% of the respondents report problems on less than 5% of their roads. In extraordinarily bad years, 55% report problems remain limited to 5% or less of their roads. Finally, in 1989-90, about 50% report problems on less than 5% on their road systems.

Landsliding from the hillslope above the road corridor is sited as a cause of mass-erosion problems on 5-25% of their road networks by about one-third of the respondents. Failures of the road back-cut are cited by an equal number of respondents as affecting as little as 1-5% and up to 50% of their road networks. Failures of substantial road fills are problems on up to 10% of the roads for 65+% of the respondents. Failures of sidecasts affect the greatest portion of the road networks for about 65%. Half the respondents cite problems with headward extensions of landslides initiated below their roads on up to 10% of their road network.

Sixty percent indicate that active and inactive roads are very or somewhat affected by mass movements. Abandoned and orphaned roads are cited as very or somewhat affected by only about 20%.

Respondents most frequently indicate that either 1-5% or more than 50% of the roads less than five years old are most affected by slides/failures. Six-to-ten percent of roads 5-10 years old are most affected. Twenty-to-fifty percent of the roads between 10-20 years old are most affected, while the percentage of roads from 20-40 years old climbs to 50+%. Up to 10% of the roads more than 40 years old are most affected by slides/failures.

Approximately 85% of the respondents believe that current road construction and maintenance techniques result in significantly fewer mass movements than in the past. A wide variety of techniques are cited as reducing the number of failures. Old construction techniques are cited as the most frequent cause of mass movements, with long-term decay of old roads a somewhat distance second cause. Poor siting and/or design, lack of adherence to current design or construction standards, lack of necessary maintenance, and conducting forest activities in inherently unstable terrain are all cited by one-quarter to one-third of the respondents as frequent mass movement causes.

TEMPORARY, ABANDONED AND ORPHANED ROADS

Approximately half the respondents indicate that less than 10% of their roads built in a typical year are temporary (i.e. will be abandoned after use). From 10-50% of the roads are temporary for almost 40% of the respondents. Less than 10% indicate that more than half of their roads are temporary. Temporary roads are typically in use from 1-2 years and from 1-5 years for two-thirds and four-fifths of the respondents, respectively. Only one respondent indicates that temporary roads are used for more than five years.

Three-quarters of the respondents do not reduce the size of culverts based on the length of time a temporary road will be in place. Of those that do down-size, almost 40% find the downsizing to be very or somewhat effective.

Culvert removal is cited as the most effective method to protect public resources when roads are abandoned. Seeding bare soil, seeding/mulching bare soil, intercepting groundwater flows, and outsloping are rated as very or somewhat effective by 60-65% of the respondents. Installing water bars is rated the least effective method. Both temporary and permanent techniques are used to design stream crossings for eventual abandonment.

Half the respondents have programs in place to identify drainage or stability problems with abandoned, orphaned or inactive roads. A wide variety of methods are utilized to evaluate and deal with tension cracks, log culverts, failures of ditch drainages, slumping of cut banks and blown-out culverts. These programs are considered to be very or somewhat effective in reducing risk downstream by almost 85% of the respondents.

MISCELLANEOUS

Slightly more than half of the respondents rate the forest practices rules as effective in addressing forest road issues. About 15% of the remainder do not use these rules. The most frequently cited strengths of the rules are their flexibility in determining the best management practices for a given situation and that they are readily understandable. The most frequently cited weaknesses are inconsistent interpretation, lack of enforcement, and lack of assessment of cumulative effects. A wide variety of innovative and particularly effective road construction and maintenance practices are offered as models.

C. COMPILATION OF RESPONSES

o Number of questionnaires tabulated: 46

o Geographic origin of responses

	#	% of Total		#	% of Total
Southwest	7	15	South Puget Sound	7	15
Southeast	7	15	Central	6	13
Northeast	6	13	Out-of-state	1	2
Northwest	4	10	Anonymous	1	2
Olympic	7	15	Total	46	100

NOTE: The following rating scale is utilized for questions or effectiveness, unless another system is specifically indicated.
0 = Do hog use; i Very effective; £ = Somewhat effective; 3 = No sgnificant effect; 4 = Somewhat ineffective; 5 = Very ineffective; 6 = No opinion.

SECTION 1: INTRODUCTION

1. Who do you work for?

	#	% of Total
large industrial landowner	16	35
federal government	15	33
state government	12	26
small landowner	1	2
forestry consultant	2	A
other	0	0
Total	46	100

2. What fields do you work in?

	#	% of Total
planning and design	40	23
administration	31	18
compliance approval	33	19
construction	34	19
maintenance	30	17
other	8	4
Total	176	100

Other:

o fisheries/watershed management
o bridge design
o surveying
o road management

How many years have you worked on/with forest roads?

	#	% of Total
0-2 years	0	0
2-5 years	1	2
5-10 years	5	12
10-20 years	19	43
more than 20 years	19	43
Total	44	100
no response	2	

What area of the state do you primarily work in?

		#	% of Total
DNR region		11	24
Southwest	3		
Southeast	2		
Northeast	1		
Northwest	2		
Olympic	1		
South Puget Sound			
Central	2		
National Forest		16	34
BIA, Spokane Agency	1		
Wenatchee	2		
Gifford Pinchot	4		
Mt Baker-Snoqualmie	1		
Umatilla	1		
Olympic	3		
Colville	4		
industrial tree farm		14	30
county		3	7
Kittitas	1		
Chelan-King	1		
Snohomish	1		
other		2	4
Small private landowners			
Total		46	100

Approximately how many miles of road does your agency/company build in a typical year?

	#	% of Total
0	1	2
1-5	11	26
6-10	2	4
11-20	7	17
21-30	7	17
31-50	7	17
51 +	7	17
Total	42	100
no response	4	

6a. How many miles of road are maintained in an active state?

	#	% of Total
0-2	0	0
2-5	1	2
6-10	5	12
11-20	10	22
21-30	5	12
31-50	11	26
51 +	11	26
Total	43	100
no response	3	

How many miles of road are maintained in an inactive state?

	#	% of Total
0	3	6
1-25	2	5
26-100	9	21
101-200	8	19
201-500	14	33
501-1,000	5	11
1,000+	2	5
Total	43	100
no response	3	

7a. Do you believe TFW should sponsor a workshop on forest roads

	#	% of Total
yes	27	60
no	4	9
not sure	14	31
Total	45	100
no response	1	

7b. Would you attend such a workshop?

	#	% of Total
yes	36	80
no	3	7
not sure	6	13
Total	45	100
no response	1	

7c. What is the best time of year for such a workshop?

	#	% of Total
fall	2	4
winter	34	76
spring	8	18
summer	1	2
Total	45	100
no response	1	

How many persons participated in completing this questionnaire?

	#	% of Total
1	25	60
2	8	18
3	2	5
4	4	10
5	1	2
6 +	2	5
Total	42	100
no response	3	

SECTION 2: BRIDGES AND MAJOR CULVERTS (fish-bearing streams)

Design Flows

How do you determine culvert size?

	#	% of Total
design flood	33	27
channel width (or multiple of)	29	23
culverts downstream	23	19
basin area	32	26
other	7	5
Total	124	100
no response	2	

Other:

- o frequency of flooding-soil composition
- o based on long-term channel profile & channel control
- o experience
- o Talbot Table
- o Geological graphs

2. What design-flow recurrence interval is used?

	#	% of Total
10-year	1	2
25-year	6	10
50-year	27	44
100-year	24	39
other	3	5
Total	61	100
no response	2	

Other:

- o heavy rainfall
- o 2.1 for 30-year for culverts
- o 2-year for fish passage

3. What are the culverts designed for?

	#	% of Total
headwater depth	31	26
sediment passage	24	20
fish passage	35	30
debris passage	26	22
other	2	2
Total	118	100
no response	1	

Other:

- o unrestricted flow
- o to adequately control runoff in all conditions

How effective are the following in determining design flows for fish-bearing streams?

a) US Soil Conservation Service TR-55
b) US Soil Conservation Service TR-20
c) US Army Corp of Engineers HEC-1
d) unit-hydrograph methods
e) rational method
f) USGS publications
g) DOT methods
h) other methods
- o end area calculation at high water mark with factors for 50-year flood design
- o Manning formula
- o Weyerhaeuser Technical Report
- o McGreer Method (Weyerhaeuser Corp.)
- o Armco Drainage Calculator
- o FSH 7709.56b, Drainage Structures Handbook

	0		1		2		3		4		5		6		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	#	%			
a)	25	62	1	2	4	10	1	2	0	0	1	2	9	22	41	100	5
b)	19	63	0	0	2	4	1	3	0	0	1	3	10	26	39	100	6
c)	21	55	0	0	1	3	2	5	1	3	1	3	12	31	38	100	8
d)	16	41	3	8	7	17	1	3	2	5	2	5	8	21	38	100	8
e)	8	22	5	14	12	32	1	3	6	16	0	0	5	13	37	100	9
f)	12	32	6	16	7	17	1	3	0	0	2	5	10	27	38	100	8
g)	25	69	0	0	0	0	0	0	0	0	0	0	11	31	36	100	10
h)	10	40	7	28	2	8	1	4	1	4	0	0	4	16	25	100	

5. Are these methods regionalized to your area?

	#	% of Total
yes	17	43
no	8	20
not sure	15	37
Total	40	100
no response	6	

6. What additional tools or information about design flows for fish-bearing streams would be helpful?

Stream classification & geomorphology
High quality infurnation on flood events, frequency, severity
Snow depth info/precip, guage stations
SCS & USGS baseline stations
Tools that incorporate natural & human factors
Season of heaviest use
Soils above pipe installation
Know the species of fish and you will know the height (maximum) that fish can jump for the next leg of the journey.
Simple handouts showing placement wishes for non-professionals doing work.
Indexed summary of streams with known discharge records. Possibly a joint, ongoing, up-dateable project?
Maximum culvert flow during non-peak discharge, and expected fish escapement.
Stream channel dominant discharge.
Report 74-336 (USGS) flood discharge data should be updated.
Equivalent of "Prediction of Peak Flows on Small Watersheds in Oregon for Use in Culvert Design," A.W·R.A, Water Resources Bulletin, Vol. 20 No. 1, February 1984 - (Localized for Washington).
Publish flow information more often.
Given the variables of stream morphology, guide books or cookbooks are only guides· I don’t believe additional tools or information will be any more valuable than what we have. All culvert design decisions need to rely on knowledge about the particular stream’s structure.
Data based upon regional area, software for computations, publications.
The physics and hydrology involved in altering the channel at culverts.
Method has been very reliable - another not needed.
The U.S.G.S.method of culvert sizing should be computerized (IBM-PC compatibles).
More drainage specifics.
The information used by us is adequate.
Better information on magnitude, area, and frequency of intense storms in nearby areas.
Low flow and high flow.
Culvert design.
Gradient of stream/pipe vs. fish passage.

How applicable the other methods are for our location: N.E· Washington and mountain streams. How much sediment/turbidity is allowable· What are the effects (quantitative) of timber harvest on runoff?

Amount of current and projected use by fish.

Debris Passage

Do you modify your bridge or culvert flow capacity to account for passage of organic debris during flood flows?

		#	% of Total
yes		28	72
no		8	21
not sure		3	7
	Total	39	100
no response		7	

Comments:

o Depends on stream conditions

8· Do you modify your bridge or culvert flow capacity to account for passage of organic debris and sediment during debris flows?

		#	% of Total
yes		23	54
no		17	40
not sure		3	6
	Total	43	100
no response		3	

9· If you design for debris passage, please explain your method(s) for increasing flow capacity.

SWAG

Increasing size of structure

Add 1/3 to diameter of pipe

Eliminate maximum debris by proper riparian leave zone·

Look at area and sizes of debris with potential to affect CMP and past personal experience.

Bridge clearance, channel/structure configuration, catch basins, CMP slope, discharge design.

Subjective - depends on stream size slope, debris type and size·

Horizontal/vertical clearance for anticipated debris size (root wads, whole trees, whatever) above 100-year flood level·

Move up one size from computed size·

By putting in bridges we usually have enough room for debris·

Historical data, previous debris flows·

Armored overflow.

Guess/estimate.

Look upstream for size and amount of debris to handle when reasonable·

Some factor of safety is included in a normal flow calculation.
Allow 10′ from OHW level to bottom of bridge stringer.
Bridges only - on likely debris streams we go 10 feet above high water mark to bottom of bridge stringers.
We try to build @ +6′ above flood to allow for debris passage.
Freeboard allowance.
Generally one size larger.
Add 20-30% of cross sectional area for bridge. After culvert has washed out, then replace with oversize CMP and trash rack.
Concrete vented fords - passage over road surface, larger and higher structures.
We design for 3/4 full at 30 year flood.
By enlarging size of culvert for design requirements by 20%.
Raise bridge elevation. Grade sag.
Raising bridge elevation.
Usually 3′ of freeboard, unless specific site conditions require more.
W.A.G. not really, but kind of: 1) stream gradient, 2) type of debris, 3) size of anticipated debris, 4) size of watershed

How effective is this method(s) in providing adequate flow capacity?

0		1		2		3		4		5		6		Total		No response
#	%	#	%	#	%	#	%	#	%	#	%	#	%			
4	10	15	37	10	24	1	2	4	10	4	10	3	7	41	100	5

11. Do you employ special techniques for protection of stream crossings from debris jamming?

		#	% of Total
yes		37	86
no		5	12
not sure		1	2
	Total	43	100
no response		3	

12. How effective are the following techniques in protecting roads from debris and flood flows?

a) armored wingwalls
b) armored fills
c) removable grates
d) trash racks
e) overflow spillways
f) other techniques
- o pave road surface in curves & rolling dips
- o seeding with hydro-mulcher and cover with hay or straw
- o low-fill height over culvert
- o overflow culvert

o reduced fill over culverts
o bevel pipe - upper end
o preformed drop culverts
o fords

	0 #	0 %	1 #	1 %	2 #	2 %	3 #	3 %	4 #	4 %	5 #	5 %	6 #	6 %	Total		No response
a)	3	7	14	33	2	48	2	5	1	2	0	0	2	5	43	100	3
b)	0	0	12	31	18	49	5	14	0	0	1	3	1	3	37	100	9
c)	22	51	3	7	8	19	4	9	3	7	0	0	3	7	43	100	3
d)	8	19	7	17	13	32	2	5	5	12	0	0	6	15	41	100	5
e)	7	17	13	32	14	35	1	2	2	5	1	2	3	7	41	100	5
f)	6	29	8	37	5	24	0	0	1	5	0	0	1	5	21	100	

13. How effective are the following techniques in protecting water quality and/or fish habitat from debris and flood flows?

a) armored wingwalls
b) armored fills
c) removable grates
d) trash racks
e) overflow spillways
f) other techniques
  o pave road surface in curves
  o wing deflector within culvert to moderate velocity & facilitate passage
  o bottomless arch
  o fords

	0 #	0 %	1 #	1 %	2 #	2 %	3 #	3 %	4 #	4 %	5 #	5 %	6 #	6 %	Total		No response
a)	4	9	10	23	17	40	3	7	3	7	0	0	6	14	43	100	3
b)	2	5	13	30	18	40	4	9	1	2	0	0	6	14	44	100	2
e)	16	37	3	7	7	16	5	12	2	5	2	5	8	18	43	100	3
d)	6	14	3	7	16	38	6	14	2	5	2	5	7	17	42	100	4
e)	7	17	9	22	11	27	2	5	2	5	0	0	10	24	41	t00	5
f)	9	43	5	24	0	0	1	5	0	0	0	0	6	28	21	100	

What additional tools or information about debris passage would be helpful?

vegetation type/logging method/slash disposal/reveg methods
research on techniques in 13
info on what constitutes barrier to fish
knowing what areas are high risk for flooding
Have sufficient patrols during flooding periods to eliminate cause (i.e., keep your streams clean @ culverts when possible.)

Not much! Debris transport potential is too dynamic, since it is influenced so heavily by what’s going on upstream - fresh logging, recent blow-down, bank erosion, etc.
Assume culvert will plug, and what will happen then, and design to overtop.
Charts for rates of sediment travel, in relation to stream velocity and soil type classifications. (General guide to gradient designs.)
Beavers are making big comebacks more information on ways to prevent them from using CMP’s as a dam site.
Geological formations, publications.
Illustrations of successful installations related to the specific character of the flow would help provide guidelines. I do not feel that any reasonable rule or guideline would have broad applicability.
Information on the design and construction of high-water fords.
Effectiveness of various trash rack designs.
Beaver control.
Common sense!
No structures can stop damage from a large debris flow.
Debris flow is not predictable in either timing or magnitude.
Where the road is placed in regards to the gradient - it makes a big difference.

Stream Crossings

15. Does your initial road alignment planning consider needed stream crossings?

	#	% of Total
yes	45	100
no	0	0
not sure	0	0
Total	45	100
no response	1	

16. How effective are the following criteria for locating major stream crossings in protecting roads?

a) logging system layout
b) access and ownership
c) bank stability
d) preferred road alignment
e) road alignment limitations
f) favorable approach angles
g) stream gradient
h) other criteria
   o Stream width

	0		1		2		3		4		5		6		Total		No
	#	%	#	%	#	%	#	%	#	%	#	%	#	%			response
a)	0	0	15	35	16	36	5	12	2	5	2	5	3	7	43	100	3
b)	1	2	12	30	10	23	8	19	2	5	6	14	4	9	43	100	3
c)	1	2	34	81	5	12	0	0	2	5	0	0	0	0	42	100	4
d)	0	0	19	45	15	36	6	14	2	5	0	0	0	0	42	100	4
e)	0	0	18	43	18	43	2	5	3	7	1	2	0	0	42	100	4
f)	0	0	21	53	12	30	3	7	3	7	1	3	0	0	40	100	6
g)	0	0	8	26	14	45	6	20	1	3	0	0	2	6	31	100	15
h)	5	56	4	44	0	0	0	0	0	0	0	0	0	0	9	100	

17. How effective are the following criteria for locating major stream crossings in protecting water quality and/or fish habitat?

a) logging system layout
b) access and ownership
c) bank stability
d) preferred road alignment
e) road alignment limitations
f) favorable approach angles
g) stream gradient
h) other criteria
   - o channel profile stability
   - o channel controls
   - o soil type, erosion events (mass wasting), riparian cover & density

	0		1		2		3		4		5		6		Total		No
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	response
a)	0	0	18	45	12	30	4	10	2	5	3	7	1	3	40	100	6
b)	2	5	9	22	8	20	12	29	2	5	5	12	3	7	41	100	5
c)	0	0	31	74	6	14	2	5	2	5	0	0	1	2	42	100	4
d)	0	0	13	34	15	38	7	18	2	5	0	0	2	5	39	100	7
e)	0	0	19	46	11	27	6	15	2	5	1	2	2	5	41	100	5
f)	0	0	20	51	10	25	5	13	1	3	2	5	1	3	39	100	7
g)	0	0	17	44	11	29	6	16	1	3	2	5	1	3	38	100	8
h)	2	40	3	60	0	0	0	0	0	0	0	0	0	0	5	100	

18. What additional tools or information about siting of major crossings would be helpful?

Stream survey & geomorphology

Fish species & season of use periods

Peak flow calculations

Water holding capacity of soils

Vegetation cover in drainage

There are several computer models that professional engineers and engineering geologists use for determining bank stability. On our forest we use a process that includes the measurement of materials (rock, soil, and water) and conditions of these materials on field-developed cross-sections and plan maps. For detailed strength of materials determination we have utilized our materials lab for testing.

Reasonable approach by D.O.F. & D.O.E. Personnel instead of frequently encountered confrontational attitude. Too often technical problems remain unresolved because of "us vs. them" problems.

Increasing road grade to get in and out of drainage area.

Locate potential areas of streambed degradation!

Reliable models of debris flow risk at the proposal site.

Publication of a handbook may be useful to those inexperienced with the concerns.

Greater use of integrated road system, irrespective of landowner. This may require legal changes. Currently landowners only cooperate when mutually beneficial.

A schematic of different draw types with different crossing designs and a discussion of the pros and cons.

Try crossing where stream is the straightest.

Geological data, publications.

Less interference and more cooperation.

How do you measure debris stability upstream of potential crossing.

Presence of any alternate parallel channels needs to be recognized. Also important to recognize threats of dam-burst flood from upstream canyon.

Erosion control measures; soil types, i.e., which soils are more likely to fail; stream gradient; scour potential.

To have a training course or briefing paper, for road locators, on the important parameters to look for when locating stream crossing (bridges and culverts).

Information in 17 & 18 is very important: others include soil type, stability, amount of rock on the road, weight of fills, etc.

Fish Passage

19. How effective are the following guidelines in ensuring fish passage?

a) Forest Practices Board Manual
b) DOF guidelines
c) USFS guides

- o Fish Mitigation & Fish Passage
- o FSH 7709.56b and "Fish Versus Culverts" ETR 7700-5
- o FSH 7709.56 Road Preconstruction Handbook

d) Other guidelines

- o fisheries biologist
- o WA hydraulic permit application process & recommendations
- o Forest stream survey manual info on barriers

	0		1		2		3		4		5		6		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	#	%			
a)	7	17	9	22	16	39	3	7	2	5	0	0	0	10	41	100	5
b)	9	24	13	33	6	15	3	8	1	3	1	3	6	15	39	100	7
c)	13	35	7	19	8	22	2	5	0	0	0	0	7	19	37	100	9
d)	6	50	1	8	4	34	0	0	0	0	0	0	1	8	12	100	

20. What additional tools or information about designing for fish passage would be helpful?

Natural history & season of use (region & forest stream surveys)
Fish populations/species
See "Fish Versus Culverts" and FSH 7709.56b 6.2a Design Requirements for fish passage. FSH 7709.56 Road Preconstruction Handbook
Design procedures and effects analysis of footing scouring and undermining in bottom-less arches due to placement of boulders in culvert barrel to enhance fish passage. This appears to be a source of culvert failure.
Analysis of fish passage problems during periods of low flow with minimum headwater depth in over-sized culverts.
Same as Q. 18: Reasonable approach by D.O.F. & D.O.E. Personnel instead of frequently encountered confrontational attitude. Too often technical problems remain unresolved because of "us vs. them" problems.
Designing roads to balance steams’ proportions of pools, ripples and runs - 33% for each section.
Stream x-sections and profile, fish species, hydrology.
Handbook depicting photos of examples, and arranged for quick reference use, rather than as a textbook.
Same as Q. 6: Simple handouts showing placement wishes for non-professionals doing work.
I feel our engineering unit does a good job, and we haven’t had any problems in my district.
A schematic of available structures and under what circumstances they are most effective.
Stream shocking for evidence of anadromous fish, on-site evaluation WDF and WDW.
Information on fish physical capabilities.
Don’t need any.
Data to support DOF requirement of 1/2% or less on culverts.
Possible adverse effect of sedimentation of culvert. Information on cost-effective open bottom structures.

Updated information as developed.
Specific understanding of how stream sediments can be rearranged over several years time to result in partially blocked culverts.
Knowledge of where fish are located; knowledge of species capabilities.
Any you could get us.
Unbiased biological opinions.

Temporary Crossings

21. In what cases do you use temporary crossings (such as fords, temporary bridges, or culverts) instead of permanent structures?

Mostly in ditchlines of main road-spur junctions
Short-term roads
Intermittent streams
Summer crossings
One-time access
Seasonal streams
Economics/access needs/areas where stream flow characteristics favor fords, ie fans. Also, consider impact to water qualities.
For non-system roads
When harvesting a small patch of timber that does not justify a permanent expenditure.
Only on temporary roads.
Very few, and limit crossing during summer months in dry stream beds.
When the road will be utilized for current logging only - road not needed for permanent management needs.
On temporary roads; log bridges are used on all live streams.
On single use roads.
Where access is to be stopped after the activity. Also as protection to water in the event of water flow during the activity.
T-4 & T-5 waters for skidding purposes to enhance bank stability.
Temporary culverts, bridges seldom used on one season roads. Maybe five culverts a year. Have had one bridge in seven years.
When timber volume value does not justify a permanent structure.
1) Where cost and practicality prohibit installing a permanent structure. 2) Where the road is needed for 2 seasons or less.
Quite often.
Use of temporary bridges only, for short seasonal use.
Only when DOF or USFS wants temps.
Not used in several years.
No permanent access needed (20+ acres).
Very infrequent - emergency basis usually.
For temporary roads we use fords where bridges may not be feasible due to cost or drift.
We use temporary bridges or culverts on high volume (flow) streams when only a small amount of ownership needs access. One time access to log, then pull back.
Small acreage access - usually summer projects.

Used on short spurs that we won’t be using again until the next rotation.
Temporary crossings are used when access is required for only one operating season.
When we need access for one unit to be logged in one season.
Crossing would be at the end of a spur road.
Seasonal entry or when economics don’t justify permanent structure.
One time entry for logging. Cost of permanent structure too high.
Isolated ownership that may be traded in the future.
When limited harvesting/reforestation/fire protection constraints apply.
When permanent access is not needed.
Short term or emergency roads and to facilitate permanent construction.
For one-time or one-season crossing. Have also used CMP with wood-chip fill that was removed two times, for temporary use in two seasons, in steep stream with high risk of debris flow in water.
Another innovative temporary crossing of fish stream used 25-30 small diameter poles placed parallel to flow to fill a channel. Then placed plywood sheets with filter fabric and 6" rock surfacing, contained by 8" brow-logs. Low impact to stream for use during winter low flow for a few weeks. Low impact to remove.
On temporary roads that will be ’obliterated’ after project use. On permanent roads that will be allowed to brush in between uses.
For construction of temporary roads.
Temporary roads.
Whenever possible.
On short-term (to be abandoned) or intermittent use roads.
On intermittent or short term roads.
Short term use - one entry type.
Areas where there is a timber sale with only one period of entry for at least ten years. In wildlife habitat sensitive areas.
Short term seasonal (dry) use roads.

How effective are your temporary crossings in providing access?

0		1		2		3		4		5		6		Total		No response
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
2	5	5	12	28	67	3	7	2	5	1	2	1	2	42	100	4

23. How effective are your temporary crossings in protecting water quality and/or fish habitat?

0		1		2		3		4		5		6		Total		No response
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
2	5	25	60	11	25	0	0	2	5	2	5	0	0	42	100	4

What additional tools or information about temporary crossings would be helpful?

- Research on protection
- Mitigation & rehab opportunities
- New techniques
- Foundation materials/season of use/amount of use
- Options: railroad car bridges (removable), steel plates.
- Integrated harvest plans to be sure a single-time use is a single-time use.
- Simple handouts to show how curb logs can be used to help with stability.
- We use portable bridges.
- Information on new types of portable structures.
- We generally would not use a temporary crossing unless it was of an emergency nature.
- Type of ford that would be acceptable to DOF and DOW. What types of temporary bridges/structures are available.
- A bigger bag of tricks, i.e. greater experience with innovative techniques.
- Getting word out to TSO's and loggers.
- Fewer roads by using helicopter for access.
- Summary of temporary crossing types, costs, and spans that are acceptable to the Washington D.O.W.

SECTION 3: MINOR STREAM CROSSINGS (headwaters, side streams)

Design Flows

Approximately how many minor-crossing culverts do you install/review each year?

	#	% of Total
0-10	4	10
11-50	10	27
51-100	13	33
101-500	9	23
501+	3	7
Total	39	100
no response	7	

Approximately what proportion of your minor-crossing culverts need repair or replacement each year?

	#	% of Total
0-1%	13	29
2-5%	23	51
6-10%	8	18
11+ %	1	2
Total	45	100
no response	1	

3. What are typical types of failures? (check as many as appropriate)

	#	% of Total
debris **jams**	32	41
hydraulic damming	13	17
fill failure	15	19
other	18	23
Total	78	100
no response	4	

- o replacement of older undersized cross drains & stream crossings, replacement of old structurally failed pipes
- o rust & beavers
- o cut slope failures
- o lack of fill depth on original replacement
- o headwall damage due to grading, rocks rolling
- o sediment damming
- o age
- o undersized when installed
- o usually mechanical - smashed from heavy equipment
- o grader damage
- o footing scour

What are typical causes of these failures?

	#	% of Total
catastrophic storms	33	22
mass soil or rock movements	18	12
landslide/dam-break floods	15	10
under-design	21	14
poor location	14	9
debris jams (from debris torrents)	21	14
improper construction (placement)	14	9
other	15	10
Total	151	100
no response	1	

Other:

- o corrison/decay of pipe structure
- o rust & beavers
- o debris dam construction by beavers
- o channel shift within alluvial fan
- o culvert bottom worn away
- o poor routing maintenance
- o debris-limbs, rocks - that blocks or partially blocks intakes
- o usually minor organic accumulations block flow
- o failure to clean ditch

5. Do you use the same design flow methods for minor stream crossings as for major crossings?

		#	% of Total
yes		28	62
no		16	36
not sure		1	2
	Total	45	100
no response		1	

How effective are the following in determining design flows for minor streams?

a) US Soil Conservation Service TR-55
b) US Soil Conservation Service TR-20
c) US Army Corp of Engineers HEC-1
d) unit-hydrograph methods
e) rational method
f) USGS publications
g) DOT methods
h) other methods

	0		1		2		3		4		5		6		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
a)	20	67	0	0	0	0	2	7	0	0	0	0	8	26	30	100	16
b)	20	67	0	0	0	0	2	7	0	0	0	0	8	26	30	100	16
c)	20	67	0	0	0	0	2	7	0	0	0	0	8	26	30	100	16
d)	15	47	5	16	3	9	1	3	3	9	0	0	5	16	32	100	14
e)	9	28	6	18	7	21	3	9	1	3	1	3	6	18	33	100	13
f)	15	44	8	23	1	3	1	3	2	6	1	3	6	18	34	100	12
g)	16	70	0	0	0	0	0	0	0	0	0	0	7	30	23	100	23
h)	6	32	7	37	1	5	3	16	2	10	0	0	0	0	19	100	

Other:
o experience, observation - 3
0 stream weir - measurements
o FHWA engineering circulars

Are these methods regionalized to your area?

		#	% of Total
yes		17	50
no		10	29
not sure		7	21
	Total	34	100
no response		12	

What additional tools or information about design flows for minor streams would be helpful?

Same as Q. 6: Equivalent of "Prediction of Peak Flows on Small Watersheds in Oregon for Use in Culvert Design," A.W.R.A, Water Resources Bulletin, Vol. 20 No. 1, February 1984 (Localized for Washington).
Data on how we are doing.
Data based upon regional area, software for computers, publications.
Insist on review of design (size) by designer during wet period.
Multiple culverts are sometimes used, but are only somewhat effective.
Additional training in watershed.
More current information.

Debris Passage

Do you modify your culvert flow capacity to account for debris (organic and/or sediment) passage?

	#	% of Total
yes	23	53
no	16	37
not sure	4	10
Total	43	100
no response	3	

Comment:
o depends on drainage above culvert

If you design for debris passage, please explain your method(s) for increasing the capacity.

Increase 1/3 calculated diameter
FSH 7709.56b. You increase capacity by oversizing
Same as Q. 9: Horizontal/vertical clearance for anticipated debris size (root wads, whole trees, whatever) above 100-year flood level.
Overflow spillway and stilling basin. Low profile fill.
Same as Q. 9: Subjective - depends on stream size, slope, debris type and size.
Increase size, control angle of inlet, design catch basins.
Same as Q. 9: Look at area and sizes of debris with potential to affect CMP and past personal experience.
Same as large streams.
Needs to pass the larger loose roads which are in the stream bed.
Historical data within area.
Oversized CMP’s in sensitive areas.
"Seat of pants" method - depends on specifics of site, an estimate
Up one size.
Usually specify a larger than normal culvert size. Never install culverts less than 18" in diameter.

By looking at upstream size and amount of material, normally increase size to pass material during high water. If this isn't reasonable we'd consider other things such as trash racks.
Although headwater depth is the design method, some factor of safety will allow debris passage. In addition, often times the placement of a smaller relief culvert allows water passage after debris blockage.
Larger pipe.
Depends on assessment of potential upstream for debris flows. Don't use culvert if high risk. Double culvert if moderate risk.
3/4 full at 30 year flood - sometimes design pipe out of draw so debris slide does not plug pipe.
Grade sag; armored fill; low fill, or no fill.
Reduce fill height - then only clean catch basin; increase culvert size.
Oversize the culvert.

11. How effective is this method(s) in providing adequate flow capacity?

0		1		2		3		4		5		6		Total		No response
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
6	17	14	40	7	20	2	6	5	14	0	0	1	3	35	100	11

12. Do you employ special techniques for protection of culverts from debris jamming?

		#	% of Total
yes		25	66
no		10	26
not sure		3	8
	Total	38	100
No response		8	

How effective are the following techniques in protecting roads from debris and flood flows?

a) armored wingwalls
b) armored fills
c) removable grates
d) trash racks
e) overflow spillways
f) other techniques
  - o utilize debris & silt reservoir at intake of culvert
  - o low water fords
  - o overflow culverts
  - o dip road grade into/out of crossing, so if water overflows into ditch or road surface, then it won't go too far

o ditch dams
o fords

	0		1		2		3		4		5		6		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	#	%			
a)	10	24	9	22	14	33	5	12	2	5	1	2	1	2	42	100	4
b)	2	5	17	42	16	39	2	5	1	2	3	7	0	0	41	100	5
c)	16	42	3	8	7	18	5	13	1	3	3	8	3	8	38	100	8
d)	4	11	9	24	14	37	4	10	4	10	2	5	1	3	38	100	8
e)	8	21	10	26	10	26	0	0	4	10	3	7	4	10	39	100	7
f)	2	13	5	50	8	50	0	0	0	0	0	0	1	6	16	100	

14. How effective are the following techniques in protecting water quality and/or fish habitat from debris and flood flows?

a) armored wingwalls
b) armored fills
c) removable grates
d) trash racks
e) overflow spillways
f) other techniques
o ditch dams
o fords

	0		1		2		3		4		5		6		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	#	%			
a)	6	16	6	16	13	34	6	16	1	3	2	5	4	10	38	100	5
b)	0	0	14	37	15	37	6	16	1	3	1	3	1	3	38	100	6
c)	15	43	0	0	7	20	4	11	3	9	2	6	4	11	35	100	8
d)	6	15	5	13	14	36	6	15	4	11	1	3	3	7	39	100	8
e)	6	17	9	26	13	33	2	6	2	6	2	6	2	6	36	100	9
f)	3	33	4	45	2	22	0	0	0	0	0	0	0	0	9	100	8

What additional tools or information about debris passage would be helpful?

Grass seeding the lands.
"Erosion Prevention and Control on Timber Sale Areas" John P. Potyondy USDA-FS, Intermountain Region (1981).
Publications, historical data.

Approximately what percentage of cross-drains in your area fall in each category?

	0%		1-10%		11-25%		26-50%		52-100%		Total		No
	#	%	#	%	#	%	#	%	#	%	#	%	response
12" culverts	3	18	10	58	2	12	0	0	2	12	17	100	29
15" culverts	0	0	9	43	4	19	7	33	1	5	21	100	25
18" culverts	0	0	1	3	0	0	17	45	21	52	38	100	8
2&" culverts	0	0	15	43	13	37	7	20	0	0	35	100	9
larger than 24" culverts	3	14	12	55	7	31	0	0	0	0	22	100	24
slot-top culverts	6	86	0	0	0	0	0	0	1	14	7	100	39
water bars	2	9	15	67	3	14	1	5	1	5	22	t00	24
drivable dips	3	14	13	62	4	19	1	5	0	0	21	100	25
other	0	0	0	0	0	0	0	0	0	0	0	0	

How effective are the following in determining cross-drain spacing?

a) Forest Practices Board Manual
b) DOF guidelines
c) USFS guides
- o FSH 7700 and Intermountain Soils Erosion Manual
- o FSH 7109.26
- o Preconstruction Handbook

d) other guidelines
- o local experience
- o Transportation Engineeris Handbook 7709.11
- o DNR specs, for waterbars at end of road use

	0		1		2		3		4		5		6		Total		No
		%	#	%	#	%	#	%	#	%	#	%	#	%		%	response
a)	8	19	14	33	11	26	2	5	1	2	0	0	6	15	42	100	
b>	18	47	5	13	4	11	1	3	1	3	0	0	9	23	38	100	
c)	13	34	10	26	7	18	1	3	0	0	0	0	8	19	38	100	
d)	7	32	9	41	1	5	1	5	0	0	0	0	4	17	22	100	

3. Do you typically adjust cross-drain spacing for any of the following reasons?

	#	% of Total
do not need to adjust	1	1
slope position (example: decrease spacing down the hillslope)	32	13
highly erodible soils	41	16
presence of groundwater	43	18
annual precipitation	29	12
rain-on-snow hazard area	27	11
road grade (percent)	45	18
drainage density	24	10
other	3	1
Total	244	100
no response	1	

Other:
- o naturally-like switchbacks-slope changes-upslope becomes downslope & can drain off.
- o curvature of road - try to drain prior to blind curves
- o aspect/vegetation/groundwater/etc - see FSH on Design

4. What criteria do you use for determining cross-drain discharge points?

	#	% of Total
none	1	1
dips in topography (unchannelized)	38	28
erosion hazard below discharge point	37	27
nose of slopes	22	16
grade of road	34	25
other	4	3
Total	136	100
no response	3	

Other:
- o If spacing allows - areas of low cutbank preferred
- o Road alignment and roads below

How effective are the following types of downspouts (spillways)?

a) flumes (1/2 round culvert)
b) full culvert with open elbow
c) full culvert closed elbow
d) rigid plastic
e) plastic socks (elephant nose)
f) rock rip-rap
g) slash and/or other harvest by-products

	0 #	0 %	1 #	1 %	2 #	2 %	3 #	3 %	4 #	4 %	5 #	5 %	6 #	6 %	Total #	Total %	No response
a)	5	13	19	48	10	25	3	8	1	3	0	0	1	3	39	100	7
b)	6	16	18	47	10	26	3	8	1	3	0	0	0	0	38	100	8
c)	10	25	10	25	8	20	5	12	5	12	0	0	3	6	41	100	5
d)	16	44	2	6	4	11	5	14	1	3	2	6	6	16	36	100	10
e)	11	31	7	19	8	22	1	3	5	14	3	8	1	3	36	100	10
f)	0	0	19	42	16	37	4	9	2	4	2	4	2	4	45	100	1
g)	11	28	5	12	13	32	4	10	5	12	1	3	1	3	40	100	

6. How effective are the following methods in protecting the road prism from erosion? (check as many as appropriate)

a) seeding of cut and fill slopes
b) seed and mulch cut and fill slopes
c) utilize slash and other harvest by-products on fill slopes
d) use energy dissipators on culvert outfalls
e) other
- o specify a little longer culvert than normal
- o splash aprons
- o hand plant shrubs in dense, contour-parallel layers. Armor toe of cut with rip-rap, 1-2’ high, sometimes 5-8’

	0 #	0 %	1 #	1 %	2 #	2 %	3 #	3 %	4 #	4 %	5 #	5 %	6 #	6 %	Total #	Total %	No response
a)	2	5	9	21	26	60	5	12	1	2	0	0	0	0	43	100	3
b)	4	9	15	36	19	44	3	7	1	2	0	0	1	2	43	100	3
c)	14	34	5	12	14	33	4	10	2	5	1	2	1	2	41	100	5
d)	3	10	9	31	11	39	3	10	2	7	0	0	1	3	29	100	17
e)	1	33	0	0	2	67	0	0	0	0	0	0	0	0	3	100	

If these methods do not work well, please explain why.

Slash will decay in some cases too soon to protect slopes, may cause road failure.
Slash works okay except if it winds up in the ditches. It then becomes a cause for erosion if it diverts water onto roadway.
Only somewhat effective for short time only.
On suitable sites, natural vegetation will invade. On unsuitable sites, grass-seed and hydro-mulch is mainly a waste of time.
A critical time for new embankments is the first winter/spring after construction. Any seeding does not have sufficient time to develop a root mass for stabilization; seeding is a long term stabilization. A mechanical means is necessary to ensure the initial short term stabilization, i.e. slash, rock, etc.
If the slope is too steep, nothing will stay until an angle of repose is reached. We need to tighten up road construction laws.
Grass does not bind soil well.

Seed does not always sprout. Erosion occurs under slash.
Most of the erosion takes place before these measures take effecT.
Grass is primarily esthetics. Naturally seeded-in alder and brush is best.
Difficulties in getting seed to grow in sterile, dry soil conditions.
Generally seeding and mulch washes off before it has a chance to take hold. This method will stop "rain pounding" erosion but is ineffective for small soil movements common on new roads.
Culvert should be at or near bottom of fill.
Wrong tool in the wrong place. No tool, by itself, is good or bad. This list, plus many more are used very successfully in the appropriate circumstances.
Some soil types need more than seed/mulch (too wet or steep).
Sometimes seeding done at wrong time of year for grass to grow.

How effective are the following methods in protecting water quality and/or fish habitat?

a) seeding of cut and fill slopes
b) seed and mulch cut and fill slopes
c) utilize slash and other harvest by-products on fill slopes
d) use energy dissipators on culvert outfalls
e) other

	0		1		2		3		4		5		6		Total		No response
		%	#	%	#	%	#	%	#	%	#	%	#	%			
a)	1	2	9	23	25	62	3	7	2	4	0	0	1	2	41	100	5
b)	4	10	9	23	24	60	2	5	0	0	0	0	1	2	40	100	6
c)	9	24	3	8	10	28	9	24	3	8	1	3	2	5	37	100	9
d)	2	10	8	40	7	30	1	5	1	5	0	0	2	10	20	100	26
e)	2	9	12	55	6	26	0	0	1	5	1	5	0	0	22	100	

9. If these methods do not work well, please explain why.

Need monitoring to provide this info.
Same as Q. 7: Slash will decay in some cases too soon to protect slopes, may cause road failure.
Most sediment comes from new road construction. Side slopes don’t have a chance to revegetate before winter storms come.
Same as Q. 7: Only somewhat effective for short time only
Same as Q. 7: On suitable sites, natural vegetation will invade. On unsuitable sites, grass-seed and hydro-mulch is mainly a waste of time.
Sometimes the mulching/seeding just creates lumps that fall into creek. Slash just seems to keep moving down hill.
Slash helps some in stopping water drop energy and assisting erosion in some cases, but not adequately distributed on high lead sites in most cases.

Grass does not bind soil well.
Seed does not always sprout. Erosion occurs under slash.
Generally seeding and mulch washes off before it has a chance to take hold. This method will stop "rain pounding" erosion but is ineffective for small soil movements common on new roads.
Same as Q. 7: Wrong tool in the wrong place. No tool, by itself, is good or bad. This list, plus many more are used very successfully in the appropriate circumstances.
Very wet soils can slide no matter what treatment is used.

10. What additional tools or information about cross-drain design would be helpful?

Same as Q. 15: "Erosion Prevention and Control on Timber Sale Areas" John P. Potyondy USDA-FS, Intermountain Region (1981).
Proper angle across road - 30o.
Publications.
Regionally localized maximum culvert spacing for ditch relief.
Recommendations.

SECTION 5: EROSION PROTECTION FOR FILL

1. Do you typically protect fills adjacent to streams from erosion?

		#	% of Total
yes		36	82
no		8	18
not sure		0	0
	Total	44	100
no response		1	

2. How effective are the following methods in protecting fill?

a) rip-rap
b) erosion blankets
c) gabions
d) other
  o retaining walls - 2
  o seeding & mulching - 3
  o armor fills

	0		1		2		3		4		5		6		Total		No
		%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	response
a)	2	5	23	59	13	33	0	0	1	3	0	0	0	0	39	100	7
b)	19	42	4	10	12	26	4	10	0	0	0	0	6	12	45	100	1
c)	12	29	16	38	9	21	1	2	2	5	0	0	2	5	42	100	4
d)	6	35	6	35	4	24	0	0	1	6	0	0	0	0	17	100	

3. Forest Practices regulations require that the 50-year flood level be determined when placing fill near streams. How effective are the following methods in determining the 50-year flood level?

a) Forest Practices Board Manual
b) frequency analysis, flood routing
c) USFS guides
   o FSH 7109.26
   o Drainage Structures Handbook
d) other
   o weirs
   o common sense

	0 #	0 %	1 #	1 %	2 #	2 %	3 #	3 %	4 #	4 %	5 #	5 %	6 #	6 %	Total #	Total %	No response
a)	7	17	10	25	13	32	4	10	1	2	0	0	6	14	41	100	5
b)	7	20	10	29	5	14	3	9	2	6	0	0	8	22	35	100	11
c)	17	46	6	16	5	14	1	3	1	3	0	0	7	18	37	100	9
d)	8	50	1	6	1	6	0	0	1	6	2	13	3	19	16	100	

4. Do you provide protection above the 50-year flood level?

	#	% of Total
yes	25	60
no	14	33
not sure	3	7
Total	42	100
no response	4	

5. What additional tools or information about fill protection would be helpful?

Types of chemical soil stabilizers
Studies showing effectiveness of hydromulching
Look at bridges in the vicinity and see how they have withstood the ravages of time.
Publications, tours.

SECTION 6: MASS MOVEMENT

Within your region or area, approximately what percentage of your organization’s road network suffers from some kind of landsliding?

	0-1%		1-5 %		6-10%		11-25%		26+ %		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	
in "normal" years	16	40	19	48	2	5	2	5	1	2	40	100	6
in wet years	10	29	15	43	5	14	2	6	3	8	35	100	11
in extraordinarily bad years	9	22	14	34	6	15	7	17	5	12	41	100	5
in 1989-90	15	38	8	21	6	15	7	16	4	10	39	100	7

Approximately what percentage of the mass-erosion problems on your roads are caused by each of these processes?

a) landsliding from the hillslope above the road corridor
b) debris flow/torrent initiated upstream
c) failure of the road back-cut
d) failure of substantial road fill (e.g. at stream crossings
e) failure of sidecast
f) headward extension of a landslide initiated below the road
g) other

	0-1%		1-5 %		6-10%		11-25%		26-50%		51+ %		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
a)	2	5	3	8	14	37	11	29	6	16	2	5	38	100	8
b)	4	10	4	10	8	20	19	46	4	10	2	4	41	100	5
c)	3	7	9	22	9	22	8	20	11	27	1	2	41	100	5
d)	4	12	14	41	9	26	4	12	3	9	0	0	34	100	12
e)	1	3	5	13	6	16	14	37	11	29	1	3	38	100	8
f)	6	19	7	22	8	25	6	19	5	15	0	0	32	100	14
g)	3	33	0	0	3	33	0	0	3	34	0	0	9	100	

On a scale of 1-5, with l=most affected and 5=least affected, rate the effects of mass movement on each of these types of road.

a) active roads
b) inactive roads
c) abandoned roads
d) orphaned roads

	1		2		3		4		5		Total		No Response
	#	%	#	%	#	%	#	%	#	%	#	%	
a)	17	40	8	19	6	14	7	17	4	10	43	100	3
b)	7	17	18	42	11	26	5	10	2	5	43	100	3
c)	3	8	5	13	9	24	7	18	14	37	38	100	8
d)	3	9	5	15	8	24	10	29	8	23	34	100	12

4. Of the slides/failures within the road corridor, approximately what percentage of the roads that are affected fall within the following age categories?

a) Less than 5 years
b) 5-10 years
c) 10-20 years
d) 20-40 years
e) More than 40 years

	0-1%		1-5 %		6-10%		11-25%		26-50%		51+ %		Total		No response
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
a)	2	5	13	33	8	19	4	10	3	8	10	25	40	100	6
b)	2	5	5	14	15	41	8	21	6	16	1	3	37	100	9
c)	1	3	5	17	6	21	4	14	9	31	4	14	29	100	17
d)	2	5	7	18	4	11	6	16	8	21	11	29	38	t00	8
e)	1	6	5	29	5	29	3	18	2	12	1	6	17	100	29

On a scale of 1-5, with l=most frequent and 5=least frequent, rate the frequency of the following causes of mass movement of/around your organization’s roads.

a) poor siting and/or design
b) lack of adherence to current design or construction standards
e) lack of necessary maintenance on road-beds, fill, or sidecast
d) lack of necessary maintenance on drainage ditches and structures
e) long-term decay of old roads
f) conducting forest activities in inherently unstable terrain, where some road failures are inevitable
g) old construction techniques: large fills, incorporation of slash and debris in fills, etc.
h) other
- o many roads were constructed over existing RR grades. Mass movements seem to develop from debris flow during heavy rain.
- o Storms
- o intense storm affected plug culverts that saturated nearby road fill, leading to fill-slope failure

	1		2		3		4		5		Total		No Response
	#	%	#	%	#	%	#	%	#	%	#	%	
a)	4	10	8	20	9	22	8	21	12	27	41	100	5
b)	4	10	5	13	2	5	15	38	14	34	40	100	6
c)	3	8	10	26	4	10	12	30	10	26	39	100	7
d)	4	9	4	9	17	40	13	30	5	12	43	100	3
e)	8	19	12	28	9	21	11	26	3	6	43	100	3
f)	4	20	9	23	11	28	9	23	7	16	40	100	6
g)	17	40	10	24	8	19	3	7	4	10	42	100	4
h)	0	0	3	13	5	22	9	39	6	26	23	100	

In general, do you think that the road construction and maintenance techniques currently utilized result in significantly fewer failures than in the past?

		#	% of Total
yes		38	86
no		2	5
not sure		4	9
	Total	44	100
no response		2	

If yes, what specific techniques are reducing the number of failures?

Less side cast & more full bench
Not burying debris
Better design & location
ID Team review of location, design, soil surveys
Full bench construction requirements
Non-geometric designs. Smaller cuts & fills. Better locations
Reduce number of road miles built.
Minimizing sidecast construction by going to full bench design as much as possible. Minimize costs for high cutslope construction (to achieve full bench) by using cost effective support or retaining structures (e.g.: hilfiker walls). Compaction techniques and testing for compliance has improved quite a bit over the last 15-20 years. By completing site specific geotechnical investigations with engineering geologists and geotechnical/geological engineers in areas of predicted instability, many problems that have occurred prior to 20 years ago have been dealt with in a cost effective manner and also protect resources. In other words, it is critical to have a professional geotechnical section available to complete this type of work.
Better maintenance, more and bigger culverts.
High level of compaction of fills and sub-grades. Extensive use of geo-textiles, resulting in less rock depth and narrower sub-grades. Larger and more frequent cross-drains. Reconstruction of old sidecast roads. More full-bench construction. More thorough geo-technical investigations before final location and design.
Using filter cloth and perforated pipes.
1) End haul unstable material - do not place on unstable slopes. 2) Keeping organic material out of fills and sidecast. 3) Providing adequate cross-drains.
More and larger pipes, dipped fills, armored fills, water bars, more bridges, hydromulch, filter fabric, road fabric, rock fills.
Extra cautious management.
Education of people making decisions in the field.
No sidecast on steep slopes >35-40%; better ditch requirements; large culverts; armored fills; armored headwalls and catch basins for CMP’s; tighter compliance.
Site location, improved maintenance.
Better alignment and bigger culverts.

Less dirt moving, narrower roads beds, end push and haul areas, larger diameter culverts, more frequent cross drainages, grass seeding, rip-rap fills, location and design of roads, ridge top vs. mid slopes.

Fill compaction. Removal of organic debris from fills. Most important, use of excavator instead of crawler/dozer.

Not accepting failures as a way of life. Designing to prevent and/or minimize problems.

Limiting sidecast on slopes over 65%.

Continuous effort to clean ditches and culverts and to replace failed or plugged culverts on acting road systems. Proper abandonment procedures such as culvert removal, water barring and slope removal of inactive roads.

Increased emphasis on drainage maintenance.

The reduction or elimination of sidecast road construction techniques, particularly on steep sideslopes. The use of backhoe/excavators for culvert placement, fill construction and pioneering.

Using backhoes instead of cats - less debris in fills. End haul in unstable areas.

For new construction: excavator construction of subgrade on steeper terrain and end hauling excavation on steeper or unstable terrain. For road maintenance: pulling back unstable sidecast fills on older roads and water barring high-country roads in anticipation of rain-on-snow events.

New construction techniques - excavators and end haul.

End haul construction, use of excavators, proper sizing/installation of culverts, limiting construction to proper season, more frequent maintenance. Contract road construction supervised by engineers.

Pick better stream crossings.

Better location of road - end hauling of road prism material on steep slopes. More culverts.

Keeping slash debris out of fills. Proper back and out sloping. Use of energy dissipators/flumes/plastic socks. Fill armoring when necessary.

1) Road building technology is vastly improved, 2) more attention to unstable conditions, 3) replace worn-under designed structures.

More frequent maintenance; better sitting; better education.

1) Avoid unstable areas, 2) drain-dip construction, self maintaining.

No sidecasting; armoring slopes within drainage areas; rolling grades.

No sidecast; grades to 20% to keep local roads on or near ridge top and to have 1 road down a ridge, instead of a sidehill road on each side of ridge; more use of retaining walls; better route location; narrower road template with resultant smaller backslope (less soil exposed to elements); better contract administration and construction practices - slash not buried and fills compacted.

Less sidecast, less road building.

Layer placed fills instead of sidecast improved drainage structures (size and frequency) utilizing minimum fills over drainage crossings. Rolling road grades instead of long sustained grades.

Avoiding high-risk soils with location. No more sidecast. No fill on slopes steeper than 55%.
Smaller fills, better design, less sidecasting, better control of slash/debris.
Reduction of side casting in fills. Reduction of organic debris incorporated in fills. Better location. Application of erosion control materials such as seeding and mulching, rip-rap and blankets. NOTE: We also see an increase in the number of failures due to the following factors: Reduced construction specifications. Direction to take greater risks. Direction to reduce road costs.

7. What do you think could/should be done to reduce the number of mass failures involving roads?

Better design/location & construction techniques.
More full bench construction where formerly sidecast has been used.
Tighter control of compaction & materials on larger fills.
Better geotech, soil, hydrologic analysis during project (road & timber sales) planning & implementation.
Full bench construction requirements
More use of end haud conditioning of F.P. applications
Tressling or bridging unstable areas.

There are very few mass failures, but end haul, compaction, surfacing, etc. would reduce the risk.
Have preconstruction and construction work completed by professional geotechnical staff.
More culverts to disperse water over larger area.
Spending extra money towards locating roads away from dangerous areas.
Enforce answer to Q. 6: End haul unstable material - do not place on unstable slopes.
Better design and location techniques.
Evaluate roads for hazards; be sure to place water bars discharging on stable sites.
Design road locations and harvest units with the road site and design as the main priority, rather than concentrating on the timber volume on unit configuration.
Landowners are being allowed to construct permanent roads for which they have neither the funds nor equipment to maintain. On critical area roads abandonment within a certain period should be required with a posted performance bond.
Not a problem in my district; use more soil survey/scientists; do more compliance during road construction.
Build less of them. I feel that the failures that occur now on roads built within the last 5 years are of a smaller magnitude due to the almost industry wide curtailment of off-highway trucking.
Proper design for the location.
Bridges would help.
See 6B. (Less dirt moving, narrower roads beds, end push and haul areas, larger diameter culverts, more frequent cross drainages,

grass seeding, rip-rap fills, location and design of roads, ridge top vs. mid slopes.)

Use excavator, more end haul.

Modify design during construction as needs appear.

Keep the culverts in good repair and deep ditches maintained, and armor outfalls of culverts.

Design/location improvement. Seeding bare soil in some instances.

Use of energy dissipators on the toe of steep slopes and avoid overloading steep slopes.

Layer placing of embankment.

Bring all landowners/operators up to modern construction techniques and standards. Use modern engineering techniques and design for both logging systems and road location.

Add cross-drains and more frequent visits to correct maintenance problems.

Use good construction techniques.

For new construction: excavator construction of subgrade on steeper terrain and end hauling excavation on steeper or unstable terrain. For road maintenance: pulling back unstable sidecast fills on older roads and water barring high-country roads in anticipation of rain-on-snow events.

Design for 100 year storm, better geologic formation information.

Improve road location, drainage maintenance.

Better maintenance programs; additional culverting of older roads; more commitment of dollars and people to maintaining what is already built.

Proper engineering up-front and strict adherence to plan by construction.

Geo-tech investigation.

Stay away from unstable ground. Plan for larger events (bigger culverts). Maintain culverts - especially during potential flood events. Reduce the amount of roads - helicopter.

Since 1970, the only road failures we have had (except 1) have been on roads 20-40 years old: sidecast failures or backslope failures that do not cause mass destruction to streams, or slides originating above road that come down hill, cross roads and plug culverts, and continue into stream courses. The answer to most of our problems would be sidecast removal if money were available.

Funding made available sooner to treat old decaying/failing sidecast roads with inadequate drainage structures.

1) Identify soils and "hollows" with a high potential for erosion or mass failure. Avoid locating roads here. 2) "Roll the grade" to avoid long continuous road grades, in order to reduce water collection and saturated fills. 3) Minimize total amount of road built. 4) Avoid all sidecast, including buried logs intended as sub-grade. 5) Plan to bridge some extremely hazardous soil areas.

We could, but don’t think we should.

8. What additional tools or information about mass movement would be helpful?

Foundation info./drilling.

More programs such as this for all forest road engineers in training, and in practice.

Improved access to skilled engineering geologists.

Surveys and maps illustrating mass movement areas.

Refine soil maps need to know when end-hauling is needed on specific soil types.

Ongoing discussion of successes, off-beat included.

GIS printout of soils information for each forest practice.

Publications, seminars.

A uniform risk classification for all existing roads - this then tied to a maintenance program.

Continue to review/improve database for problem areas.

Information on recognizing the potential beforehand.

If you consider landings a part of the road then I believe there should be more requirements to do better treatment after harvest.

Transfer local experience of knowledgeable field observers to "new", inexperienced folks. Acquaint road locators/designers with details of local geology.

LISA, SARA, XSTABL, field-developed cross-section method, uniform classification of geologic materials (Unified Soil Classification System, Howard, 1986; and Unified Rock Classification System, Williamson, 1984).

SECTION 7: TEMPORARY, ABANDONED AND ORPHANED ROADS

1. What proportion of the roads you build in a typical year is temporary (i.e. will be abandoned after use)?

0-1%		1-5 %		6-10%		11-20%		21-50%		51+ %		Total		No
#	%	#	%	#	%	#	%	#	%	#	%	#	%	response
8	19	6	14	9	21	9	21	7	16	4	9	43	100	3

2. For what length of time are your temporary roads typically in use?

0-1		1-2		3-5		5+		Total		No
#	%	#	%	#	%	#	%	#	%	Response
3	7	29	67	10	24	1	2	43	100	3

3a. Do you reduce the size of culverts based on the length of time a temporary road will be in place?

	#	% of Total
yes	8	19
no	32	76
not sure	2	5
Total	42	100
no response	4	

3b. If yes, please describe the criteria you use for down-sizing.

Our culverts are generally figured for a 100 year flood.
Occasionally, we use the 50 year level for temporary crossings.
Season of operation, and use of temporary CMP's.
Season work will be done. If short dry season operation - okay.
When removal is planned, minimum size to pass summer flows is used.
Downsize if CMP will not be used during wet season.
If used in dry weather, culvert size reflects this.
If the road is going to be used in the dry season we use small pipes, and remove them as soon as road is not needed - used only for very short term use.
Design for summer flow.
If the structure will be used only during the dry season and removed, it may be undersized.
Cost.
May use less frequent spacing.

4. How effective is this method(s)?

0 #	0 %	1 #	1 %	2 #	2 %	3 #	3 %	4 #	4 %	5 #	5 %	6 #	6 %	Total #	Total %	No response
10	38	5	19	5	19	0	0	4	16	0	0	2	8	26	100	20

5. How effective are the following actions in protecting public resources when roads are abandoned?

a) culvert removal
b) seed bare soil
c) seed and mulch bare soil
d) intercept groundwater flow
e) install water bars
f) outsloping
g) pull back fill and/or sidecast
h) other
   o pull back of parched landing debris

	0 #	0 %	1 #	1 %	2 #	2 %	3 #	3 %	4 #	4 %	5 #	5 %	6 #	6 %	Total #	Total %	No response
a)	2	5	20	48	12	28	3	7	0	0	4	10	1	2	42	100	4
b)	2	5	11	26	16	38	6	14	5	13	1	2	1	2	42	100	4
c)	7	17	13	31	12	28	3	7	5	13	1	2	1	2	42	100	4
d)	6	15	10	26	11	28	4	10	2	5	1	3	5	13	39	100	7
e)	26	59	12	28	3	7	1	2	1	2	1	2	0	0	44	100	2
f)	3	7	14	32	13	30	8	18	4	9	2	4	0	0	g4	100	2
g)	9	24	14	38	5	14	4	11	1	3	2	5	2	5	37	100	9
h)	0	0	1	100	0	0	0	0	0	0	0	0	0	0	1	100	

What techniques do you use to design stream crossings for eventual abandonment?

Make them simple to remove
Same as for permanent roads - 2
Minimize fill height and culvert length
Use older crossing sites when possible and try for least disturbance (mostly S.G. timber now - less than 80 years old).
Lower fill heights, select fill material (washed rock for spawning habitat enhancement), "disposable" culverts (used pipe, log culverts, etc.).
Remove culvert and rehab stream area.
Reduce fill size to minimum necessary.
We use temporary log stringer bridges with road fabric over cyclone fencing and gravel running surface.
Reduced fill height, temporary bridges, log fills.
Low fills, temporary CMP’s/bridges, specifications of abandonment.
Road blockage for safety liability.
Less fill or lower fills.
Same as permanent roads.
Minimum fill height.
Portable bridges.
Same as permanent.
Minimize fill height by shifting location.
Minimize fill depth.
Experience.
Design flow.
Consider temporary bridges.
Minimize fill.
If road over winter - same as permanent crossings. If summer flow water - low flow volume capacity design.
Shallow crossing, armoring disturbed soils, revegetate.
Temporary bridge installation, fords, drain dips, temporary culverts.
1) Temporary bridges, 2) fords, 3) drain dips, 4) temporary culverts.
Same techniques as for long term road.
If culverts needed on temporary roads, we would design same as permanent locations.
Try to avoid stream crossing with temporary roads.
Low water dips, minimum fills, utilize structures that can be easily removed.
Establish road grades next to stream crossings that will prevent water running down road surface. May either remove a CMP or remove fill from top of culvert.
Same as for minor structures.

Do you have a program in place to identify drainage or stability problems with abandoned, orphaned or inactive roads?

		#	% of Total
yes		22	51
no		19	44
not sure		2	5
	Total	43	100
no response		3	

7b. If yes, please describe your program.

To my knowledge we have only permanent and temporary roads. All permanent are maintained to at least custodial level. All temporary roads are required by law (NFMA) and policy to be revegetated.

Monitoring abandoned or inactive roads some road walking to evaluate.

Landowners are inventorying problem areas and identifying during annual maintenance meetings.

Periodic field check.

All roads are inspected and drainage maintenance done on an annual basis.

Field inspection, through maintenance people and Cavenham employees.

Periodic inspection.

Inspection on a periodic basis.

Occasional road condition survey to identify resource protection needs.

We look at nearly all of our roads on a yearly basis.

During the summer of 1989 we examined all roads/old grades, etc. for areas of instability and inventoried wooden drainage structures. We intend to replace all wooden culverts on our ownership within the next three years.

All roads were audited and a maintenance prescription was implemented on a priority basis.

Post storm road survey of past problem site. Continuous ongoing inactive road maintenance.

High risk areas based on topography, age of construction and known problems receive high priority for maintenance.

Jerry, can you do that in the space provided?

Condition surveys on the ground.

Annual condition survey; a limited survey that will check on a few areas.

Annual condition survey.

Other than our normal condition surveys that are conducted as part of our annual program, we have done specific watershed road deficiency and restoration plans for three of our major problem drainages: Finney Creek, Canyon Creek and Deer Creek.

Our watershed department has a continuing program to review major basins (6-10 total) for road problems. One basin mostly done so far.

Road condition surveys.

8. What methods do you use to evaluate and deal with the following situations?

a) Tension cracks:

Soils/geology specialists recommendations
Repair as necessary
None
Evaluate and, if necessary, stabilize or control drainage with alternate method or do nothing.
Remove obstacles upstream to avoid headwall or water in winter.
Realign road closer to cut bank.
Evaluate soil conditions, slope %, etc., to relocate roadway and remove sidecast if necessary.
Heal or pull back sidecast.
Sidecast removal, seal cracks, monitor.
Buttress toe of fills. Grade to fill cracks and seal water penetration, ditch and install additional CMP's to ensure water removal.
Ditches to redirect water above and below to stable outflow sites.
Seal to keep water out.
Length and depth, blade out with grader or cat.
Fill and seal to prevent surface water entry.
Divert water and or correct any needed drainage problem.
Repair, attempt to decompact, attention to drainage.
Break and reseal surface, keep water away from site.
Keep a closer watch for problem.
Generally will remove or modify the toe, and/or compact the grade.
Small ones are sealed during maintenance. Large ones are reported to transportation and geo-tech engineers.
Seal cracks and reduce weight on fill (drainage or slash).
Pull back.
If the potential for environmental degradation is high, if failure were to occur, we pull back the sidecast at these sites.
Excavate and investigate cause.
Seal up by grading. Keep water off area by adding protection: i.e. culverts, water bars.
Seismographic examination and usually seal with rock.
Pull back overload and stabilize out slope.
Visual.
No maintenance money is allowed to fix temporary roads and abandoned roads. Soil and water money would be needed.
Geo-tech.
Sidecast pullback, in-sloping and water barring.
May replace fill with wood-chip fill. Ensure adequate cross-drains to avoid saturated fill. Also consider removing part of fill if sidecast materials are buried, or cracks worsen.
Blade shut.
Standard geo-technical investigations if there is major resource impact potential.

b) Log culverts:

Remove from temporary roads
Replace
0nly use on seasonal streams - remove in fall
If it is cedar and still sound, leave it.
Replace during next timber sale.
0nly used for temporary roads - replace when found for active roads.
Remove if undersize or old.
Not necessarily a more significant problem than steel culverts.
Inspection program.
Inspection, scheduled removal.
Relief water bars.
Don’t use on systems in my district. If used on private land, evaluate for damage.
Inspect, replace when deterioration begins.
Replace at first indication of problem.
Annual inspection.
Remove ASAP.
Eventual removal upon failure or to prevent failure, depending on situation.
Replace at first sign of trouble.
Remove and replace with CMP.
Reported on road condition survey along with any problems being caused, then corrected by maintenance or project.
Identify and replace.
Remove.
All are in various stages of decay, but it is often difficult to determine which are in dire straits. We therefore prioritize replacement on the basis of potential for environmental degradation if failure were to occur.
Replace on priority basis.
Replace with metal.
Replace with steel culverts.
Replace when we find one.
Replace.
No maintenance money is allowed to fix temporary roads and abandoned roads. Soil and water money would be needed.
Replace when we reconstruct.
Removal and replacement (if needed for access) with new and improved drainage structures.
Remove entirely.
Remove/replace.

c) Failure of ditch drainage:

Replace as necessary after determining cause.
Redo.
Conduct stability analysis if necessary - re-establish or control drainage with alternate method or do nothing.
Clean it.
Look at adding more cross-drains.

Evaluate road grade and CMP spacing, add cross-drains, etc., to correct problem.
Line ditch, add pipes.
Reditch.
Add more cross-drains, increase ditch size, reduce velocity.
More water bars.
Take immediate action to minimize any damage/siltation.
Damage potential, open and armor if necessary.
Clean ditch.
Keep ditches cleaned out.
Ongoing inspection, backhoe and grader.
Outslope and drain dip as precaution.
Rip-rap, perforated pipe, in-slope road, reballast to raise road.
Road maintenance.
Our experience has indicated that these failures are caused by plugged ditch lines. We stress ditch cleaning in our maintenance program.
Reported to transportation engineer and road maintenance engineer.
Ditch and install new cross-drains if necessary.
Clean ditches outslope. We look at these situations on an individual basis and consider potential for damage.
Cut bank attributes. Proximity of slash and debris. Road/ditch gradient. Rainfall/rain-on-snow runoff. Drainage area.
Road maintenance survey and ongoing road maintenance.
Reshape road - outslope, add culverts, etc.
Common sense!
Depends on situation.
Repair.
No maintenance money is allowed to fix temporary roads and abandoned roads. Soil and water money would be needed.
Reinstall.
Ditch clean-out, in-sloping or water barring, depending on the level of use on the road.
Water bar/outslope.
Only if there is resource damage potential.

d) Slumping of cut bank:

Soils & geology information.
Repair as necessary after determining cause.
Seed it.
Drain water away from area and stabilize with some retaining structure.
Evaluate soil type reslope cut bank to flatter condition if needed.
Remove slump, then buttress cut bank with rip-rap.
In-slope, reditch, remove slump, buttress slopes, set road out.
Excavate larger ditch, buttress toe of cut bank, reduce angle of back slope, establish vegetation.
More water bars.
Use rock buttresses where necessary to stabilize.
Size of slump, remove material.

Clean slumped debris, if necessary buttress cut slope to prevent further slumping.
Remove potential slump by backhoe.
Reduce backslope.
Keep ditches functional.
Generally remove with back-hoe. In extreme cases we will seed the slumping bank.
Minor ones reported to road maintenance engineer and handled under maintenance. Large ones reported to transportation engineer and geo-tech,
Depending on soil types steepen or reduce cut slopes.
Leave it if drainage is not impaired.
Remove slump and reshape cut slope,
End haul.
USFS and WSDNR construction recommendations,
Most often bail out.
Repair.
No maintenance money is allowed to fix temporary roads and abandoned roads. Soil and water money would be needed.
Remove and sidecast.
Stabilization or in-sloping road bed.
Consider need to armor toe with rip-rap.
Provide drainage.
Only if there is resource damage potential.

e) Blown-out culverts:

Replace as necessary.
Replace with larger ones.
Review proper sizing techniques.
Replace it.
Evaluate culverts above and below the redesign culvert size.
Evaluate cause - replace CMP with larger pipe if required.
Reevaluate size, rock or armored fills.
Replace with rock fills, half or full bridges, trash racks, pavement roadway surfaces.
Catch basins, increase size, improve inlet configuration.
More water bars.
May need silt trap, hay bales too.
Damage potential, replace.
Repair.
Replace or water bar.
Oversize CMP’s.
Replace - reevaluate for sizing.
Most instances we replace with larger culverts if warranted. If the blow-out is the result of debris build-up it generally is a case of cleaning debris and replacing.
Reported to transportation engineer, road then blocked for safety and need to replace determined.
Replace culvert with larger size.
If we won’t need the road for quite a while, we don’t replace.

Remove, resize and replace.
Redesign evaluation, replace, bridge or leave open if an alternate route is available.
WSDOF guidelines.
Replace, abandon, it depends on need or risks.
Replace or reinstall.
No maintenance money is allowed to fix temporary roads and abandoned roads. Soil and water money would be needed.
Dip road grade - install new pipes, bridges, low water fords or concrete vented fords depending on the specific site.
Evaluate why debris flow happened. Consider replacing with an armored ford or bridge.
Only if there is resource damage potential.

10. How effective is your program in reducing risk downstream?

0		1		2		3		4		5		6		Total		No
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	response
0	0	14	39	16	44	4	11	1	3	1	3	0	0	36	100	10

11. What additional tools or information about temporary, abandoned or orphaned roads would be helpful?

A formal orphan road identification program is needed. It cannot be done on a passive basis.
What others are doing.
Publications.
Case history - scientific study showing actual causes of failures on old logging roads.
More definitive criteria from DNR for acceptable abandonment.
How to get road back into a natural state.

SECTION 8: MISCELLANEOUS

1. How effective are the forest practices rules in addressing forest road issues?

0		1		2		3		4		5		6		Total		No
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	response
6	15	8	20	14	34	5	12	3	7	0	0	4	12	41	100	5

2. What are the strengths of the current Forest Practices Rules regarding roads?

Review prior to construction.

Maintenance requirements - maintenance plans can be required as a condition of continued use.

Good info for comparison of design techniques

We have learned from our past mistakes and improved our skills from these experiences.

Everyone has a copy and the DNR members will help you design if needed. The foresters have the experience.

Has (so far) avoided the tempting trap of CMP's.

Rules address good management policies for specific areas.

Reorganization of DNR with dedicated forest practice specialists has resulted in better adherence to rules. Current rules are adequate in most cases.

ID teams.

Roads are addressed, usually the roads are not a high priority for some loggers.

Culvert sizing; clean-up requirements; construction rules.

Spell out a lot of specifics, seem clearly understandable by industry and privates. Not having a lot of problems with roads.

Good common sense construction practices, i.e. full bench loads on 60% slopes.

For new roads, design standards, CMP's are very effective.

Conditioning repair of existing roads proposed for use on a new F.P.A.

Ability to work within liberal time limits to resolve problems for maintenance.

CMP relief spacing, no organics in fills.

The guidelines are good. Too many rules stop all activity. The forest practices people are so interested in protecting their tail that innovating in application of strict rules will not be allowed.

More attention is being given to sidecast.

The ability of the state to monitor and reevalulate road construction activities. The ability of the state to control and review road construction activities on steep ground and sensitive soils.

Culverts - spacing.

The Forest Practice Rules are a good general set of rules.

The Forest Practices Rules adequately define the standards which road construction must attain, leaving the practitioner with adequate flexibility in determining the best management practices required in design, construction and maintenance in order to achieve those goals.

The Forest Practice Rules are adequate.

Provides minimum standard to operate against.

Short, well written and covers the information to design and build a stable road.

The freedom of the forest practice forester to make field calls re: slope stability, etc.

Flexible so that foresters may adjust to circumstances present.

We don't use Forest Practice Rules.

We do not use these rules to manage federal lands.

3. What are the weaknesses?

Not easy to understand - too wordy.
Can not answer questions for all circumstances.
Inconsistent DNR interpretation
Forest Service is downsizing geotechnical staff in Region 6 to the point where we will not longer be effective.
Not enough time to give seminars and illustrate proper techniques and tools available.
Has (so far) taken too weak a position on identifying specific end results.
Forest practice policies do not really address the accumulated effects of road building in areas of multiple ownership. They do not address the total picture of transportation planning by including the logging plan side of the equation, i.e. road spacing.
They don’t take into consideration the cumulative effects when large scale activities, i.e. logging and road building, are occurring in a drainage.
Lack of compliance time.
Not enough bite in the compliance.
Not enough people to enforce; some are vague; big problem is arrangement - the road laws are scattered all over and landowners really don’t know they are breaking the law; not a good track record with courts, they don’t take FP’s seriously.
Cross drain spacing, need to take into consideration soil types and gradient combinations more.
Inexperienced inspectors.
Dealing with old road systems where no new FPA’s are being proposed.
Involving priority one issues, this should be handled by field F.P. people by pre-site inspection with landowner, before 1 D team inspection if one called.
Not requiring excavators in critical road construction and CMP installation.
When a Class IV special is called for I don’t believe problem solving is as important as "tail protecting." I certainly disagree with some basic assumptions by staff "experts."
Overzealous DNR forest practices, foresters wanting to end-haul everything. On very steep slopes (65%+) limiting sidecast is important - under that, only on specific soil types and situations.
Those who monitor forest road construction, including TFW groups, often have little or no road construction experience and don’t understand the process or alternatives.
Lack of real construction experience.
I don’t see any real weaknesses.
The weakness is in the training and competence of the people that enforce the rules.
50 year design inadequate.
Too many ambiguities!
Not very uniform.
We don’t use Forest Practices Rules.

Please describe any innovative or particularly effective road construction and maintenance techniques that you utilize.

Turn piking.
Flumes & energy dissaptors
Routine road inspections & maintenance
Locate minor stream crossings in the winter
End haus of slopes 50+%
Clean out of channels during construction
We are constructing low volume roads for log haul to minimize earthwork, rather than maximize economy of construction and user costs. These roads may require more maintenance and restrictions on log hauling in poor weather, but the erosion potential is considerably less due to less disturbed ground. We attempt to minimize the amount of road constructed in riparian areas.
Mainly, work with the landowners that have been stewards for 20 to 50 years. They have seen the rivers, creeks and water sources for many years and will be in a position to offer advice in design, construction and maintenance; ask a lot of questions of the locals.
Same as Q. 6b: High level of compaction of fills and sub-grades.
Extensive use of geo-textiles, resulting in less rock depth and narrower sub-grades. Larger and more frequent cross-drains.
Reconstruction of old sidecast roads. More full-bench construction.
More thorough geo-technical investigations before final location and design.
Ravel on unstable slopes can be minimized by terracing the cut slopes. This also gives vegetation a more secure place to get started.
Temporary bridges, dipped fills, rock fills, armored fills.
Drivable rolling dips used extensively. Not water bars. Outside edge of road is cut down approximately 20-24", with gentle transition into and out of cut. Frequency of dips is dependent on grade, soil type, etc. This reduces the number of culverts required, hence road cost, and allows for a more natural side hill runoff, without creating new water concentrations when culverts are used. Contingency to road design is quickly and cheaply accommodated to result in a stable, drainage efficient road.
Future abandonment roads in unstable areas, make the whole road a future ditch as the cut bank is going to fail and fill the ditch.
Lots of water bars.
Using more subgrade reinforcing fabric, seals subgrade more.
Compact sub-grades with rollers.
End-haul unstable areas and all creek crossings.
Use excavator and experienced contractor. USFS uses "low bidder" and "cats" and has more failures than we do.
I feel my ideas are common sense.
Systematic inspection and maintenance.
Road construction - we believe that construction of the sub-grade with a hog rather than crawler tractor is beneficial. Also, the application of fabric in extremely wet soils, and scheduling construction to the degree possible during the dry season. Road

maintenance - concentrate on culvert cleaning, ditch cleaning and drainage control.
End-haul and full bench construction on side slopes of greater than 60%. Loading up the toe of rotational slumps to stabilize movement.
Relief pipe on major stream crossings to allow for water passage in the event of debris blockage. Pulling back old landings (20-30 year) to prevent debris and soil movement.
Using backhoes for pioneering roads. Looking at most of our roads at least on a yearly basis for maintenance.
Most of our new subgrade construction is accomplished with hydraulic excavators· This gives us a cheaper, more environmentally sound road as a finished product in most instances.
Size to 100 year flood. Add 6" 12" to culvert size on large fills. Access route to inlet for small backhoe.
Observation and common sense.
Developing a road maintenance overlay system that will show and track culverts. Risk assessments, water types, and other maintenance data to provide maintenance plans and field useable maps.
Woodcocks #2 shovel.
Excavator construction and compaction of fills in lifts, have to be two of the best.
Rolling grades; filter windrows at toe of fill slopes in drainages; outslope roadbed; seed roadbed; gravel steep grades.
Grade sags with grouted fills in drainages with a high potential for debris flow/sediment flow.
Steep grades; narrow templates; in-sloped roads/no ditch; water bar roads when inactive just below culvert installations.
Well trained staff.
Minimizing cuts and fills during construction even if it means steeper road/grades for short segments. Concrete vented fords on mainline roads at streams where debris torrents are suspected (repeat performers).
Other persons on Darrington Ranger District are more knowledgeable on this item.
Drop inlets in lieu of ditches. Low profile superspan arch, 12’ 5" rise, 33’ 1" span. Grouted rip-rap channel armoring. Concrete fords. Asphalt low water fords. Asphalt paved "V" shaped roads with drop inlets and catch basins.

5. Please identify any road sites which would serve as good examples of innovative or particularly effective techniques.

MRGC Access, Van Zant Dyke (Whatcom County)
We can identify typical, non-geometric service level D closed roads throughout the Forest, if any area convenient for your purpose.
Joe Kaech’s forest road, and south fork of Willapa River crossing·
Diamond Fork Road on Yakima Reservation, which is up the Klickitat River Drainage. Volcanic mud flows caused mass movements, but filter cloth and perforated pipes directed water away from area.
The Hathaway road, S17-T36N-R5E.

Plum Creek side sec. 7 (1003)w abandoned. Campbell Group Cabin Creek abandonment sec. 12 (l107)w. ****Weyco Longview maintenance program.
6000 (incline road) Sec. 26, T19N, R6W WM.
Our primary and secondary roads.
Any class IV special road project constructed by Plum Creek (Puget Sound Unit) in the last 5 years.
All of our roads.
Upper north fork of Tilton.
Fill on road 1728, N.E. 1/2 sec. 24 T. 38N., R.41E. We experienced a failure here, and some special engineering took place to stop erosion - it has worked well.
2922300; 2932 - newer construction; many other recently constructed local roads.
FS Road 2208032 and FS Road 2208043.
Finney Creek Rd #17 (MP 13.0, 15.2 - 21.0), Segelson Rd #18 (MP 15.0 - 21.0)

6, Please identify any road sites which would serve as good examples of failures.

Clearwater system, T39, R6E (Watcom County)
Spencer Creek on the Naches District (Wenatchee NF)
Hansel Creek on the Leavenworth District (Wenatchee NF)
State Highway 101 on Cosmopolis Hill.
The Slide Mountain road.
Miller Creek road.
Grays River Drainage.
Mostiff Road Slide.
USFS Procter Creek Bridge site - near Skykomish.
Kapowsin Tree Farm - 25 road system, 243 road system. King County-Granite Creek road system.
We have seen very limited failures as can be seen in other parts of this report. Consequently we do not have good examples.
Any old sidecast road, constructed by crawler tractor rather than excavator, particularly on side slopes of greater than 40%.
Plum Creek.
Lower north fork of Tilton.
Land slide on road 7015290, N.E. 1/4 sec. 26, T. 37N., R.40E. (N.E. Mill Creek).
All old roads (20-40 yrs.) in the Pistol Creek area.
FS Road 2180500; FS Road 2204200.
Finney Creek Rd # 17, MP 5.5 (now under Skagit Co.)

What additional tools or information needs, not previously identified, would be helpful?

Analysis of catastrophic failure: When culverts fail in floods, failure is many times due to inlet uplift and piping rather than over-topping. There is no analysis method for estimating drag forces causing inlet uplifting due to high water velocities and required culvert "stiffness" to resist uplifting. There is a lack of understanding and knowledge about this phenomenon.

Use aerial photos of forest areas through time see natural slumping position on hillsides - avoid this strata if mid-sloping roads.

What are the long term effects of not redesigning and reconstructing old roads?

Recommendations for fast growing, deep rooted vegetation, grasses and/or shrubs suitable for slope stabilization. Also differentiate between palatability/non-palatability for cattle grazing interest.

None - there are no fail-safe answers.

8. Additional comments.

TFW practices not applied directly on Forest. Covered by LMP and state FPA requirements, plus analysis & NEPA evaluation of projects.

Please mail me a copy of your finished report - many thanks.

I was a forester at the Yakima Reservation's Forest engineering section from 1978-1984. I have forgotten the names of the manuals we used for drainage design. We used USGS maps for rainfall and geographical factors in a formula programmed at the Yakima Reservation.

Everyone agrees that forest roads are the primary source of stream sedimentation. Yet regulations (buffer strips, RMZ's, etc.) negate the benefits of good logging layout and require more roads which just add to the sediment problem.

Hard to generalize. There is not one answer in all situations.

It is a tough job to make rules for the conscientious and the "don't care" operator at the same time. This is why goals as well as basic rules or guidelines are needed rather than a rigid set of complex rules that cannot fit all situations. As becomes obvious, most of the problems occur soon after construction. This is the area to watch the closest. Possibly more action of incipient failure of old fills. Very expensive.

Oregon State University held an excellent Forest Road Seminar several years ago (I believe it was in 1984). If CHER/SHAM is considering a forest road workshop, it would probably be wise to consult with OSU College of Forestry and University of Washington College of Forest Resources faculty.

Would like to see better training for field people. From my point of view I see TFW working and we must get beyond the rhetoric of differentiated interests and get on with a program that has proven effective.

Many of our most significant problems have also been occurring where mainline systems have been constructed 30-40 years ago into drainage basins with many segments within the flood plain (historical) of the main stream. (I.E. Portions of Glacier Creek and Canyon Creek are good examples). For many years there were no problems until the streams began to meander due to several factors and reclaim portions of the flood plain where roads had been built. My comments in this questionnaire deal mostly with construction, MTC, and design of roads. Some of the questions on fish passage and water quality are being looked at by our fisheries and watershed personnel who should be sending you a separate response. One other problem I believe is causing significant damage to water quality and fisheries is improper treatment of perched (hanging) landings after harvest. We are involved in going back to pull debris away from the outside edge of landings to reduce the potential of their triggering a failure down slope.

There are a number of questions that are ambiguous, confusing, or vague: Sec. 2, #8 - We design for debris passage during high flow condition, and not for debris flow conditions. Sec. 2, #16 & 17 - We really wrestled with this one. Does effective mean impactive? Sec. 6, #1 - What is your definition of land sliding in terms of size or effect? Our answers are in terms of percentage of miles. Sec. 7 - What is an orphaned road? Sec. 7, #8 - Situations need specific evaluations.

fin rpt